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(54) **Loudspeaker**

Lautsprecher

Haut-parleur

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Description

[0001] This invention relates to loudspeakers and in particular to compound loudspeaker drive units in which separate diaphragms are provided for reproduction of the low and high audio frequencies.

[0002] In some known loudspeaker systems, separate loudspeaker drive units are provided for reproduction of bands of audio frequencies, for example a woofer unit for reproduction of sounds in a low frequency band and a tweeter unit for reproduction of sounds in a high frequency band. The voice coils of the loudspeaker drive units are connected to the output of a power amplifier, or other source, through a suitable cross-over filter network which ensures that only electrical signals representing sounds in the appropriate bands are applied to the individual loudspeaker voice coils. The characteristic of the cross-over filter is arranged so that in a mid frequency cross-over band intermediate the low and high frequency bands the outputs of the two loudspeaker drive units tail off; the output of the low frequency loudspeaker drive unit reduces with increase of frequency while the output of the high frequency loudspeaker drive unit reduces with decrease in frequency. At a so-called crossover frequency the low and high frequency loudspeaker drive units have outputs which are equal but reduced in comparison with their outputs within their respective frequency bands. The electrical energisations of the respective voice coils are adjusted so that the sound outputs of the loudspeaker drive units are relatively matched and together provide a substantially uniform output over the total frequency range of the combination of the two loudspeaker drive units. The sound radiated from each of the drive units may be said to emanate from the apparent sound source or acoustic centre of that unit; the position of the acoustic centre is a function of the design of the particular unit and may be determined by acoustic measurement.

[0003] When separate loudspeaker drive units are provided, the apparent sound sources are physically offset from one another. The loudspeaker drive units are usually mounted on a common baffle such that they lie in a common plane and are offset in a vertical direction in the plane of the baffle. For a listener positioned approximately in line with the axes of the loudspeaker drive units and approximately equidistant from the acoustic centres of both drive units, a desired balance of output from the two drive units can be obtained. However if the position of the listener is moved from the equidistant position, the distances between the listener and the acoustic centres of the two loudspeaker drive units will be different and hence sounds in the mid frequency band produced by both loudspeakers will be received by the listener from the two drive units with a difference in time. This time difference between sounds received from the two drive units results in a change in phase relationship of the sounds received at the listening position from the two drive units. The sounds from the two drive units no longer add together as intended in the cross-over band. Consequently the resultant received sound levels will vary with frequency and the overall sound output of the loudspeaker combination will appear to the listener to be non-uniform. The resulting raggedness in sound output colours the sound and, with stereo sound systems, there is a loss of clarity in the apparent location of instruments in the sound stage. This is particularly apparent in respect of sound frequencies in the upper mid-range, for example in the region of 3kHz, at which the offset of the drive units relative to one another is comparable to the wavelength of the sound. At a frequency of 3kHz the wavelength is approximately 4 inches or 100 cm.

[0004] In an attempt to overcome the undesirable effects on sounds received at positions which are not equidistant from the two loudspeaker drive units, it is known to combine the low and high frequency loudspeaker drive units in a single compound co-axial construction. The compound co-axial loudspeaker drive unit consists of a generally conical low frequency diaphragm driven by a voice coil interacting with a magnetic structure having a central pole extending through the voice coil. A high frequency diaphragm is positioned to the rear of the structure and sound output from this diaphragm is directed to the front of the loudspeaker drive unit by means of a horn structure extending co-axially through the centre pole of the magnetic structure which interacts with the low frequency diaphragm. Thus both the low frequency and high frequency sounds are directed in a generally forward direction from the compound loudspeaker drive unit. In this co-axial form of loudspeaker construction there is no vertical or horizontal offset of the apparent sound sources for low and high frequencies. However the low frequency diaphragm is positioned at the front of the loudspeaker unit whereas the high frequency diaphragm is positioned at the rear of the loudspeaker unit and this results in relative displacement of the apparent sound sources in the direction of the axis of the drive unit and an undesirable time difference in the arrival, at the listener, of sounds from the high and low frequency diaphragms.

[0005] FR A-1 001 734 discloses a compound loudspeaker drive unit comprising a low frequency conical diaphragm flaring outwardly from a neck of the diaphragm with a voice coil secured to the neck of the diaphragm and a high frequency domed diaphragm located in the neck of the low frequency diaphragm. The drive unit includes a common magnetic structure having two concentric air gaps in which the voice coils of the low and high frequency diaphragms respectively extend. The whole of the magnetic flux for the air gap in which the voice coil of the high frequency diaphragm moves also passes through the air gap for the low frequency voice coil.

[0006] The use of a common magnetic structure makes it difficult to independently control the magnitude of flux interacting with each of the voice coils and it re-

quires that the loudspeaker drive unit be manufactured as a single complex unit instead of being capable of being manufactured as two independent separate relatively simple units which subsequently are assembled together.

[0007] GB A-2 153 628 discloses a construction of compound loudspeaker drive unit including a low frequency diaphragm and a domed high frequency diaphragm located in a central opening in the low frequency diaphragm. The low frequency diaphragm is flat or of conical or domed form extending rearwardly from the central opening thereof to avoid diffraction or tunnel effects upon the high frequency diaphragm so that the high frequency diaphragm is permitted to operate as a direct radiator. An air gap for a voice coil secured to the low frequency diaphragm is formed between an outer pole piece and a central pole piece. A magnet is located in an aperture in the end of the central pole piece and a plate on the magnet forms, with the end of the central pole piece, an air gap for a voice coil secured to the domed high frequency diaphragm.

[0008] Autosound and Communications, March 1988, page 24 ("Audiophile taps the top with 1st stereo products") and a brochure published by Audiophile in 1987 each disclose a tweeter for installation in a car, the tweeter has a neodymium-iron-boron magnet to make installation of the tweeter in the car more flexible.

[0009] US-A-4 590 333 discloses a compound loudspeaker drive unit including a low frequency driver and a high frequency driver. The low frequency driver has an inverted speaker cone, the cone extending rearwardly from a central neck region. The high frequency driver is located at the neck of the inverted speaker cone and the apparent acoustical source of the low frequency driver is substantially coincident with the apparent acoustical source of the high frequency driver. However with this construction of compound loudspeaker the low frequency driver does not impose any directivity on sound produced by the high frequency driver.

[0010] According to the invention a compound loudspeaker drive unit including a low frequency conical first diaphragm flaring outwardly and forwardly from a neck of said diaphragm to generate sounds in a low frequency range; a first voice coil carried on a voice coil former and secured to said neck of said conical first diaphragm;

a high frequency second diaphragm of domed form to generate sounds in a high frequency range; a second voice coil secured to a peripheral edge of said high frequency diaphragm; said high frequency diaphragm being located in or adjacent to the neck of the conical diaphragm;

and magnetic means including first and second air gaps in which said first and second voice coils respectively extend, said magnetic means producing a first magnetic flux in said first air gap interacting with said first voice coil and a second magnetic flux in said second air gap interacting with said second voice coil;

the magnetic means including a first magnetic structure and a first permanent magnet producing the first magnetic flux in a first magnetic flux path in said first magnetic structure and in the first air gap;

characterised in that

said low frequency diaphragm and said high frequency diaphragm are adapted to generate said low and high frequency ranges of sound overlapping in a cross-over region and both said diaphragms are adapted to make significant contributions to sound output in said cross-over region;

in that the magnetic means further includes a second magnetic structure and a second permanent magnet producing the second magnetic flux in a second magnetic flux path in said second magnetic structure and in said second air gap, said second magnetic structure being separable from said first magnetic structure;

in that said second permanent magnet is formed of a neodymium iron boron compound so that for a required magnitude of magnetic flux in the second air gap the second magnetic structure is of sufficiently small size to be accommodated within the voice coil former adjacent the neck of the first diaphragm; and

in that the first and second diaphragms have effective acoustic centres and the second diaphragm is located relative to the first diaphragm such that the effective acoustic centres of the first and second diaphragms are coincident and so that in the cross-over region the conical first diaphragm imposes a directivity upon said second diaphragm to cause the directivities of the first and second diaphragms to be matched over frequencies in the cross-over region where both diaphragms make significant contributions to the sound output of the drive unit.

[0011] An embodiment of the invention will now be described by way of example with reference to the drawing which shows a cross section through the axis of a moving coil compound loudspeaker drive unit.

[0012] Referring to the drawing, a compound loudspeaker drive unit with low frequency and high frequency transducers having co-axial low and high frequency voice coils comprises a chassis 10 in the form of a conical basket having a front annular rim 11 connected to a rear annular member 12 by means of a number of ribs 13. The rear annular member 12 has an annular flange 14 and an annular seat 15. Secured to the flange 14 is a first magnetic structure 16 for the low frequency loudspeaker drive unit. The magnetic structure 16 comprises a magnet ring 17, which may for example be formed of barium ferrite, a front annular plate 18 which forms an outer pole and a member 19 which forms a backplate and inner pole 20. The plate 18, magnet ring 17 and member 19 are held together to provide a magnetic path

interrupted by a non-magnetic air gap between the outer pole 18 and the inner pole 20. The poles are circular and form therebetween an annular air gap. The low frequency transducer or loudspeaker drive unit comprises a diaphragm 21 of generally frusto-conical form supported along the front outer edge thereof by a flexible surround 22 secured to the front rim 11 of the chassis 10. A tubular coil former 23 is secured to the rear edge of the diaphragm 21 and is arranged to extend co-axially of the air gap in the magnetic structure 16. The coil former carries a voice coil 24 positioned on the former such that the coil extends through the air gap. The coil is of sufficient axial length as to ensure that for normal excursions of the voice coil, the poles always lie within the length of the voice coil. A suspension member 25, in the form of a spider consisting of inner and outer rings interconnected by flexible legs or consisting of a corrugated sheet having annular corrugations, is secured between the coil former 23 and the annular seat 15 of the chassis 10 in order to ensure that the coil former, and voice coil carried thereby, are maintained concentric with the poles of the magnetic structure and out of physical contact with the poles during sound producing excursions of the diaphragm 21. The backplate and inner pole member 19 has a bore 26 extending co-axially thereof for the purpose of mounting a high frequency drive unit 27.

[0013] The high frequency transducer or drive unit 27 comprises a second magnetic structure consisting of a pot 28, a disc shaped magnet 29 and a disc shaped inner pole 30. The pot 28 has a cylindrical outer surface so dimensioned as to fit within the interior of the coil former 23 without making physical contact therewith. The pot is formed with a circular recess 31 to receive the magnet 29 and an annular lip 32 to form an outer pole. One circular pole face of the magnet 29 is held in engagement with the bottom wall of the recess 31 and the disc shaped inner pole 30 is held in engagement with the other circular pole face of the magnet such that the circular outer periphery of the inner pole 30 lies co-axially with and within the lip 32 forming the outer pole. A non-magnetic air gap extends between the inner and outer poles. A spacer ring 33 is secured to the front face of the pot 28. The magnet 29 is formed of neodymium iron boron which allows a very substantially enhanced magnetic field strength as compared with other available magnetic materials to be attained in the air gap between the poles. As a result, the overall size of the high frequency magnetic structure, for a required flux in the air gap, can be smaller than hitherto thereby allowing the high frequency drive unit to be positioned within the coil former of the low frequency drive unit immediately adjacent to the apex of the low frequency diaphragm 21. A high frequency domed diaphragm 34 has an annular support 35 of annular corrugated form and this support is secured at its outer periphery to the spacer ring 33. Secured to the domed diaphragm 34 is a cylindrical coil former carrying a high frequency voice coil 36 such that the voice coil extends through the air gap between the poles 30, 32 of the magnetic structure.

[0014] In order to centralise the high frequency unit relative to the low frequency unit, and in particular to ensure that the high frequency unit is coaxial with and does not interfere with motion of the low frequency voice coil a rod 37, preferably of non-magnetic material, is secured centrally to the rear face of the pot 28 and extends through the bore 26 of the low frequency magnetic structure. The high frequency drive unit tends to be held in engagement with the pole 20 of the magnetic structure 16 by magnetic attraction therebetween but is secured to the structure 16 by a threaded end portion 38 of the rod 37 extending through an aperture in a plate 39 positioned at the rear of the backplate 19 and a nut 40 threaded onto the end portion 38.

[0015] Connections to the low frequency voice coil 24 are provided by means of flexible leadout conductors 41 extending from the voice coil 24 to external connectors 42. Connections to the high frequency voice coil 36 are provided by flexible conductors 43 which extend along a recess in the outer wall of the pot 30, between the pot 30 and the inner pole 20 and thence through the bore 26 to external connectors (not shown). In order to allow the conductors to extend through the bore 26, the rod 37 has a diameter smaller than that of the bore 26 so as to leave an annular space through which the conductors 43 extend. Means, not shown, are provided between the pole piece 20 and the pot 28 to ensure that the rod lies co-axially with the bore 26. This means may be a disc secured to the pole piece 20 and having a central aperture of a diameter to receive the rod 37 in a sliding fit. The disc may be grooved to provide a passageway for the conductors 43 between the pole piece 20 and the pot 28. The rod 37 may be of circular, hexagonal or other section and the disc would be provided with a central aperture of matching shape.

[0016] Instead of utilising a rod 37 of diameter smaller than that of the bore 26, if the rod is of hexagonal section its diameter may be of a size such that the rod is a sliding fit in the bore 26 to locate the high frequency drive unit co-axially of the pole piece 20 of the low frequency drive unit Spaces between the faces of the hexagonal section rod and the wall of the bore 26 provide passageways for the conductors 43. Instead of using a plate 39 to secure the high frequency drive unit, a moulding may be used. The moulding would be located by means of a boss on the moulding entering the bore 26. The moulding may be so formed as to provide a mounting for other components such as the electronic components of a cross-over filter and terminals for electrical drive signals for the compound loudspeaker drive unit. As an alternative to the end 38 of the rod 37 being externally threaded, the end of the rod may be bored and threaded internally to receive a screw.

[0017] The construction described hereinbefore is particularly convenient in manufacture of the compound loudspeaker drive unit in that the high frequency drive

unit is centralised relative to the low frequency drive unit prior to the high frequency drive unit reaching its final rest position on the pole piece 20. As a result the high frequency unit is prevented from engaging the low frequency voice coil during assembly of the compound loudspeaker drive unit. Furthermore this construction facilitates dis-assembly of the high frequency drive unit from the low frequency drive unit if and when any servicing of the units is necessitated without any need to demagnetise either of the magnetic assemblies.

[0018] If desired, an annular baffle 44 having a frusto-conical front surface is secured to the front of the high frequency drive unit to provide a continuation of the surface of the low frequency diaphragm 21 towards the domed high frequency diaphragm.

[0019] It will be appreciated that with the high frequency drive unit positioned at or adjacent to the neck of the diaphragm of the low frequency drive unit, as in the above described construction of compound loudspeaker drive unit, the apparent sound source or acoustic centre of the high frequency drive unit is substantially coincident with the apparent sound source or acoustic centre of the low frequency drive unit The radiation pattern or directivity of the low frequency drive unit is determined inter alia by the form of the low frequency diaphragm. With the high frequency drive unit positioned adjacent to the neck of the low frequency diaphragm, the form of the low frequency diaphragm imposes its directivity upon the radiation pattern or directivity of the high frequency unit. Consequently at frequencies at which both drive units contribute significant sound output, both drive units have substantially similar patterns of radiation or directivity. As a result the relative sound contributions from the two drive units as perceived by a listener are substantially unaffected by the listener being positioned at off axis positions.

[0020] The low frequency conical diaphragm is shown in the drawing as being of conical form having an angle of flare which increases from the neck of the diaphragm toward the outer periphery of the diaphragm. However it will be appreciated that the diaphragm may be of conical form having a uniform angle of flare. Also, the low frequency conical diaphragm may be of circular, elliptical or other section as desired.

[0021] The high frequency diaphragm is shown in the drawing as being of domed form. Such a diaphragm is suitable because its acoustic centre may readily be located in close coincidence with that of the low frequency diaphragm, and because, in the frequency range where both drive units contribute significant sound output, its small size relative to wavelength gives it, by itself, essentially non-directional sound radiation, allowing the effective directivity to be determined by the low frequency diaphragm.

Claims

1. A compound loudspeaker drive unit including a low frequency conical first diaphragm (21) flaring outwardly and forwardly from a neck of said diaphragm to generate sounds in a low frequency range; a first voice coil (24) carried on a voice coil former (23) and secured to said neck of said conical first diaphragm;

   a high frequency second diaphragm (34) of domed form to generate sounds in a high frequency range; a second voice coil (36) secured to a peripheral edge of said high frequency diaphragm; said high frequency diaphragm being located in or adjacent to the neck of the conical diaphragm (21);
   and magnetic means (17, 18, 19, 20, 28, 29, 30, 32) including first and second air gaps in which said first and second voice coils respectively extend, said magnetic means producing a first magnetic flux in said first air gap interacting with said first voice coil and a second magnetic flux in said second air gap interacting with said second voice coil;
   the magnetic means including a first magnetic structure (17, 18, 19, 20) and a first permanent magnet (17) producing the first magnetic flux in a first magnetic flux path in said first magnetic structure and in the first air gap;

   characterised in that

   said low frequency diaphragm (21) and said high frequency diaphragm (34) are adapted to generate said low and high frequency ranges of sound overlapping in a cross-over region and both said diaphragms are adapted to make significant contributions to sound output in said cross-over region;
   in that the magnetic means further includes a second magnetic structure (28, 29, 30, 32) and a second permanent magnet (29) producing the second magnetic flux in a second magnetic flux path in said second magnetic structure and in said second air gap, said second magnetic structure (28,29,30,32) being separable from said first magnetic structure;
   in that said second permanent magnet (29) is formed of a neodymium iron boron compound so that for a required magnitude of magnetic flux in the second air gap the second magnetic structure is of sufficiently small size to be accommodated within the voice coil former (23) adjacent the neck of the first diaphragm (21); and
   in that the first and second diaphragms have effective acoustic centres and the second dia-

phragm is located relative to the first diaphragm such that the effective acoustic centres of the first and second diaphragms are coincident and so that in the cross-over region the conical first diaphragm (21) imposes a directivity upon said second diaphragm (34) to cause the directivities of the first and second diaphragms to be matched over frequencies in the cross-over region where both diaphragms make significant contributions to the sound output of the drive unit.

2. A compound loudspeaker drive unit as claimed in claim 1 further characterised in that the first diaphragm (21) flares outwardly with a progressively increasing angle of flare from the neck to a front peripheral edge of the diaphragm.

3. A compound loudspeaker drive unit as claimed in any preceding claim further characterised in that the low frequency voice coil carried by the voice coil former (23) secured to the neck of the low frequency conical first diaphragm (21) is spaced rearwardly from the neck of the low frequency conical first diaphragm (21) and that the second magnetic structure (28, 29, 30, 32) is disposed within said voice coil former intermediate the neck of said low frequency conical first diaphragm (21) and the low frequency voice coil (24).

4. A compound loudspeaker drive unit as claimed in any preceding claim further characterised in that the first magnetic structure (17, 18, 19, 20) and first diaphragm (21) form a first manufactured unit; in that the second magnetic structure (28, 29, 30, 32) and the second diaphragm (27) form a second manufactured unit separate from said first manufactured unit; in that the first magnetic structure includes a central pole piece (20) with a central bore (26) extending axially therethrough and that said second magnetic structure (28, 29, 30, 32) includes a rod (37) of non-magnetic material extending rearwardly from said second magnetic structure (28, 29, 30, 32) into said bore (26) to thereby locate said second magnetic structure relative to said first magnetic structure.

5. A compound loudspeaker drive unit as claimed in claim 4 further characterised in that the second magnetic structure (28, 29, 30, 32) is secured to a front end face of the central pole piece (20) of the first unit.

6. A compound loudspeaker drive unit as claimed in claim 4 or 5 further characterised in that conductors (43) providing electrical connections to the second voice coil (36) extend through the central bore between a wall of the central bore (26) and the rod (37).

Patentansprüche

1. Lautsprecherkombinationseinheit, mit einer konischen ersten Menbrane (21) für tiefe Frequenzen, die sich von einem Halsabschnitt der Membrane aus nach aussen und vorn erweitert, zum Erzeugen von Schall in einem tiefen Frequenzbereich; mit einer auf einem Schwingspulenformer (23) getragenen und am Halsabschnitt der konischen ersten Membrane befestigten ersten Schwingspule (24); mit einer kalottenförmigen zweiten Membrane (34) für hohe Frequenzen, zum Erzeugen von Schall in einem hohen Frequenzbereich; mit einer zweiten Schwingspule (36), die an einem Umfangsrand der Membrane für hohe Frequenzen befestigt ist; wobei die Membrane für hohe Frequenzen in oder bei dem Halsabschnitt der konischen Membrane (21) angeordnet ist; und mit Magnetmitteln (17, 18, 19, 20, 28, 29, 30, 32) mit einem ersten und einem zweiten Luftspalt, in welche sich die erste bzw. die zweite Schwingspule erstrecken, welche Magnetmittel im ersten Luftspalt einen ersten, mit der ersten Schwingspule zusammenwirkenden Magnetfluss und im zweiten Luftspalt einen zweiten, mit der zweiten Schwingspule zusammenwirkenden Magnetfluss erzeugen und welche Magnetmittel eine erste Magnetstruktur (17, 18, 19, 20) mit einem ersten Permanentmagnet (17) enthalten, der den ersten Magnetfluss in einem ersten Magnetflussweg durch die erste Magnetstruktur und den ersten Luftspalt erzeugt; dadurch gekennzeichnet, dass die Membrane (21) für tiefe Frequenzen und die Membrane (34) für hohe Frequenzen dazu ausgelegt sind, den tiefen und den hohen Schallfrequenzbereich sich in einem Uebergangsbereich überlappend zu erzeugen, wobei beide Membranen im Uebergangsbereich signifikante Beiträge zum erzeugten Schall liefern; dass die Magnetmittel ferner eine zweite Magnetstruktur (28, 29, 30, 32) mit einem zweiten Permanentmagnet (29) enthalten, der den zweiten Magnetfluss in einem zweiten Magnetflussweg durch die zweite Magnetstruktur und den zweiten Luftspalt erzeugt, wobei die zweite Magnetstruktur (28, 29, 30, 32) von der ersten Magnetstruktur trennbar ist; dass der zweite Permanentmagnet (29) aus einer Neodym-Eisen-Bor-Verbindung besteht, so dass für eine erforderliche Grösse des Magnetflusses im zweiten Luftspalt die zweite Magnetstruktur genügend klein ist, um innerhalb des Schwingspulenformers (23) benachbart zum Halsabschnitt der ersten Membrane (21) aufgenommen zu werden; und dass die erste und die zweite Membrane effektive akustische Zentren aufweisen und die zweite Membrane bezüglich der ersten Membrane so angeordnet ist, dass die effekti-

ven akustischen Zentren der ersten und der zweiten Membrane zusammenfallen und dass im Uebergangsbereich die konische erste Membrane (21) auf die Schallabstrahlung von der zweiten Membrane (34) eine Richtwirkung ausübt, wodurch die Richteigenschaften der ersten und der zweiten Membrane bei Frequenzen im Uebergangsbereich, wo beide Membranen signifikante Beiträge zum von der Kombinationseinheit abgegebenen Schall liefern, aneinander angepasst sind.

2. Lautsprecherkombinationseinheit nach Anspruch 1, dadurch gekennzeichnet, dass die erste Membrane (21) sich mit einem vom Halsabschnitt zu einem vorderen Umfangsrand der Membrane progressiv grösser werdenden Erweiterungswinkel nach aussen erweitert.

3. Lautsprecherkombinationseinheit nach einem der vorangehenden Ansprüche, dadurch gekennzeichnet, dass die Schwingspule für tiefe Frequenzen, die auf dem Schwingspulenformer (23) getragen ist, welcher am Halsabschnitt der konischen ersten Membrane (21) für tiefe Frequenzen befestigt ist, in einem Abstand hinter dem Halsabschnitt der konischen ersten Membrane (21) für tiefe Frequenzen liegt und dass die zweite Magnetstruktur (28, 29, 30, 32) innerhalb des Schwingspulenformers zwischen dem Halsabschnitt der konischen ersten Membrane (21) für tiefe Frequenzen und der Schwingspule (24) für tiefe Frequenzen angeordnet ist.

4. Lautsprecherkombinationseinheit nach einem der vorangehenden Ansprüche, dadurch gekennzeichnet, dass die erste Magnetstruktur (17, 18, 19, 20) und die erste Membrane (21) eine erste vorgefertigte Einheit bilden; dass die zweite Magnetstruktur (28, 29, 30, 32) und die zweite Membrane (27) eine von der ersten vorgefertigten Einheit getrennte zweite vorgefertigte Einheit bilden; dass die erste Magnetstruktur ein zentrales Polstück (20) mit einer zentralen Bohrung (26) enthält, die sich axial durch das Polstück erstreckt, und dass die zweite Magnetstruktur (28, 29, 30, 32) einen Stab (37) aus nichtmagnetischem Material enthält, der sich von der zweiten Magnetstruktur (28, 29, 30, 32) nach hinten in die genannte Bohrung (26) erstreckt und die zweite Magnetstruktur bezüglich der ersten Magnetstruktur zentriert.

5. Lautsprecherkombinationseinheit nach Anspruch 4, dadurch gekennzeichnet, dass die zweite Magnetstruktur (28, 29, 30, 32) an einer vorderen Stirnfläche des zentralen Polstücks (20) der ersten Magnetstruktur befestigt ist.

6. Lautsprecherkombinationseinheit nach Anspruch 4 oder 5, dadurch gekennzeichnet, dass Leiter (43), welche elektrische Verbindungen mit der zweiten Schwingspule (36) herstellen, sich zwischen einer Wand der zentralen Bohrung (26) und dem Stab (37) durch die zentrale Bohrung erstrekken.

Revendications

1. Dispositif d'excitation pour haut-parleur composé comprenant un premier diaphragme conique à basse fréquence (21) s'évasant vers l'extérieur et vers l'avant à partir d'un col dudit diaphragme pour engendrer des sons dans une gamme de basses fréquences; une première bobine mobile (24) supportée sur une armature de bobine mobile (23) et fixée audit col du diaphragme conique;

   un second diaphragme à haute fréquence (34) de forme bombée destiné à engendrer des sons dans une gamme de hautes fréquences; une seconde bobine mobile (36) fixée à un bord périphérique du diaphragme à haute fréquence; le diaphragme à haute fréquence étant installé dans le col ou à proximité du col du diaphragme conique (21);
   et des moyens magnétiques (17, 18, 19, 20, 28, 29, 30, 32) comprenant un premier et un second entrefers dans lesquels lesdites première et seconde bobines mobiles s'étendent respectivement, lesdits moyens magnétiques produisant un premier flux magnétique dans ledit premier entrefer interagissant avec ladite première bobine mobile et un second flux magnétique dans ledit second entrefer interagissant avec ladite seconde bobine mobile;
   les moyens magnétiques comprenant une première structure magnétique (17, 18, 19, 20) et un premier aimant permanent (17) produisant le premier flux magnétique dans un premier trajet de flux magnétique dans ladite première structure magnétique et dans le premier entrefer;

caractérisé en ce que ledit diaphragme à basse fréquence (21) et ledit diaphragme à haute fréquence (34) sont à même d'engendrer lesdites gammes sonores de basse et haute fréquences qui se chevauchent dans une région de chevauchement et lesdits deux diaphragmes sont à même d'apporter des contributions significatives à la production sonore dans ladite région de chevauchement; en ce que les moyens magnétiques comprennent, en outre, une seconde structure magnétique (28, 29, 30, 32) et un seconde aimant permanent (29) produisant le second flux magnétique dans un second trajet de flux magnétique dans ladite seconde structure magnétique et dans ledit second entrefer, ladite secon-

de structure magnétique (28, 29, 30, 32) étant séparable de ladite première structure magnétique; en ce que ledit second aimant permanent (29) est formé d'un composé néodyme fer bore, de sorte qu'en vue d'une amplitude requise de flux magnétique dans le second entrefer, la seconde structure magnétique est d'une taille suffisamment petite pour pouvoir être logée dans l'armature de bobine mobile (23) à proximité du col du premier diaphragme (21) ; et en ce que les premier et second diaphragmes ont des centres acoustiques efficaces et le second diaphragme est installé par rapport au premier diaphragme de façon que les centres acoustiques efficaces des premier et second diaphragmes coïncident et que dans la région de chevauchement, le premier diaphragme conique (21) impose une directivité sur ledit second diaphragme (34) afin de faire en sorte que les directivités du premier et du second diaphragmes soient concordantes sur des fréquences situées dans la région de chevauchement où les deux diaphragmes apportent des contributions significatives à la production sonore de l'unité d'excitation.

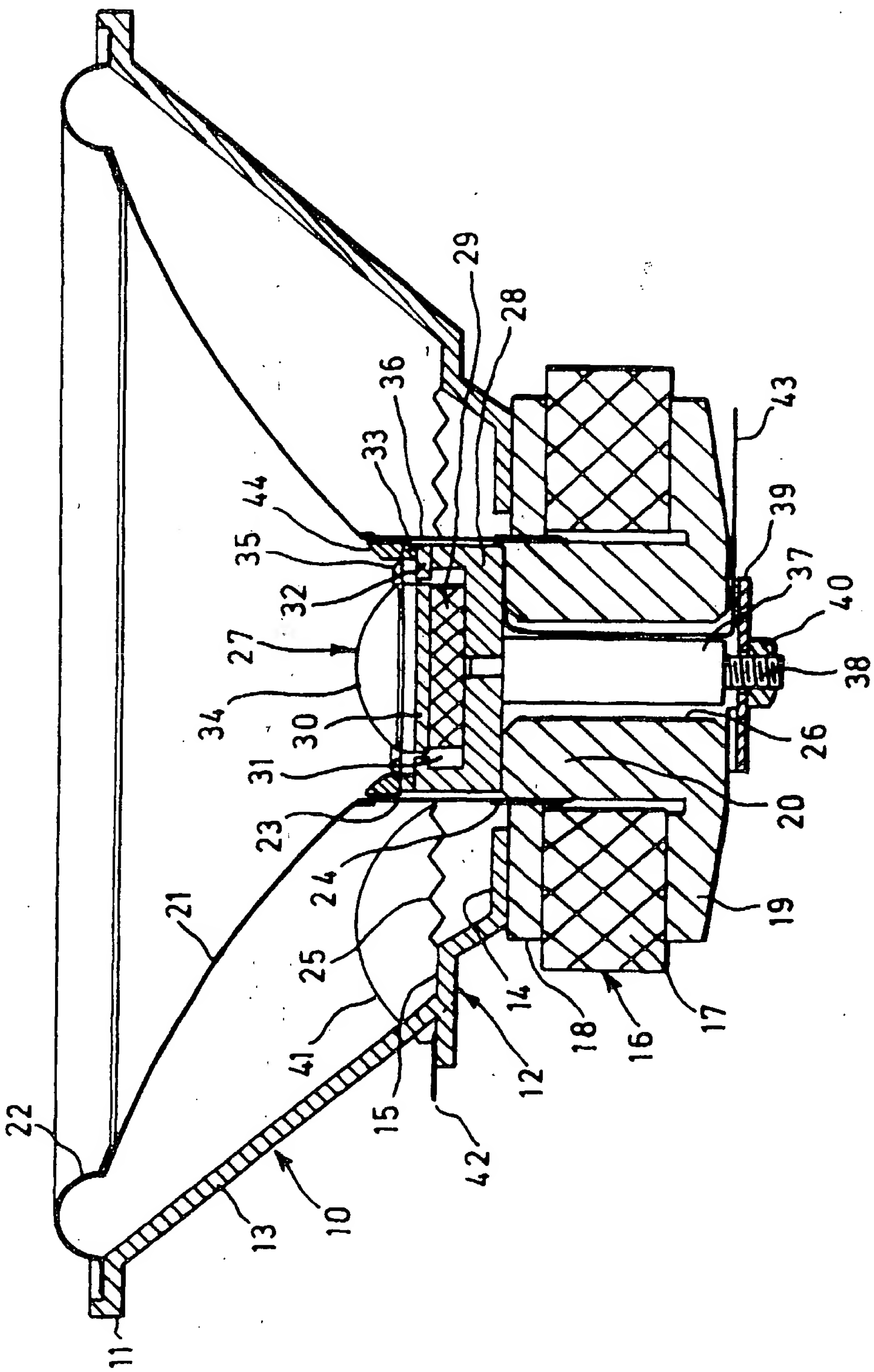
2. Unité d'excitation pour haut-parleur composé suivant la revendication 1, caractérisée, en outre, en ce que le premier diaphragme (21) s'évase vers l'extérieur sous un angle d'évasement progressivement croissant depuis le col jusqu'à un bord périphérique extérieur du diaphragme.

3. Unité d'excitation pour haut-parleur composé suivant l'une quelconque des revendications précédentes, caractérisée, en outre, en ce que la bobine mobile à basse fréquence supportée par une armature de bobine mobile (23) fixée au col du premier diaphragme conique à basse fréquence (21), est espacée vers l'arrière du col du premier diaphragme conique à basse fréquence (21) et que la seconde structure magnétique (28, 29, 30, 32) est disposée dans ladite armature de bobine mobile entre le col dudit premier diaphragme conique à basse fréquence (21) et la bobine mobile à basse fréquence (24).

4. Unité d'excitation pour haut-parleur composé suivant l'une quelconque des revendications précédentes, caractérisée, en outre, en ce que la première structure magnétique (17, 18, 19, 20) et le premier diaphragme (21) forment une première unité manufacturée; en ce que la seconde structure magnétique (28, 29, 30, 32) et le second diaphragme (27) forment une seconde unité manufacturée séparée de ladite première unité manufacturée; en ce que la première structure magnétique comprend une pièce polaire centrale (20) présentant un alésage central (26) qui la traverse axialement de part en part et que ladite seconde structure magnétique (28, 29, 30, 32) comprend une broche (37) en matière non magnétique qui s'étend vers l'arrière à partir de ladite seconde structure magnétique (28, 29, 30, 32) dans ledit alésage (26) pour positionner ainsi ladite seconde structure magnétique par rapport à ladite première structure magnétique.

5. Unité d'excitation pour haut-parleur composé suivant la revendication 4, caractérisée, en outre, en ce que la seconde structure magnétique (28, 29, 30, 32) est fixée à une face d'extrémité avant de la pièce polaire centrale (20) de la première unité.

6. Unité d'excitation pour haut-parleur composé suivant la revendication 4 ou 5, caractérisée, en outre, en ce que des conducteurs (43) fournissant des connexions électriques à la seconde bobine mobile (36) s'étendent à travers l'alésage central entre une paroi de l'alésage central (26) et la broche (37).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